

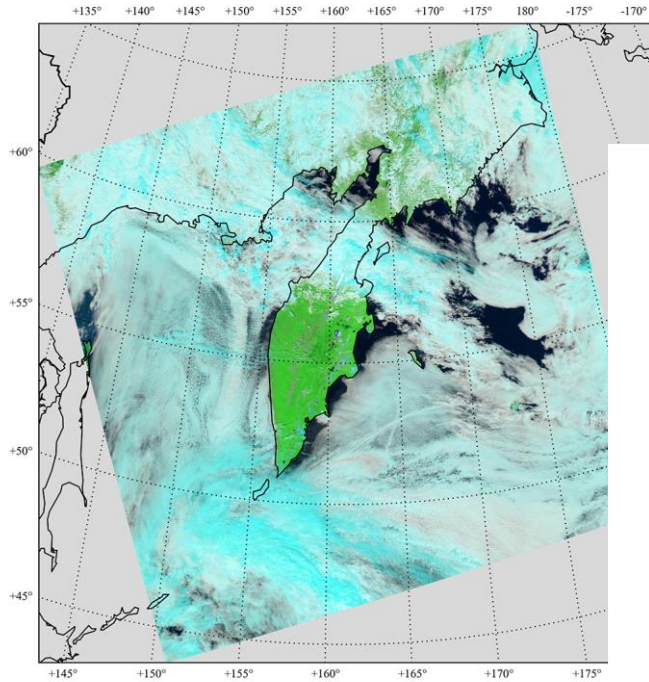
# MODIS-VIIRS inter-sensor shortwave radiometric monitoring by the Cloud Product team and the A-SIPS

NASA GSFC: **Kerry Meyer**, Steven Platnick

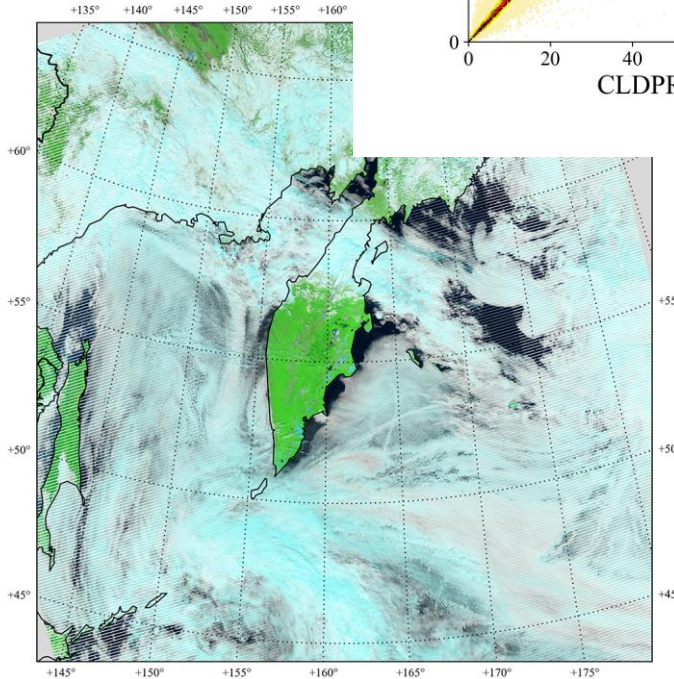
Atmosphere SIPS: **Bob Holz**, Steve Dutcher, Zach Griffith, Greg Quinn

# Background

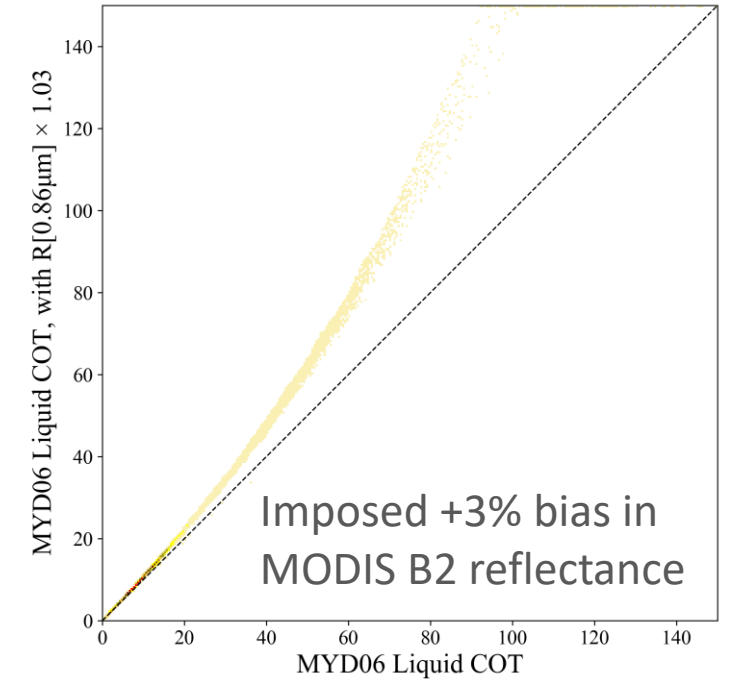
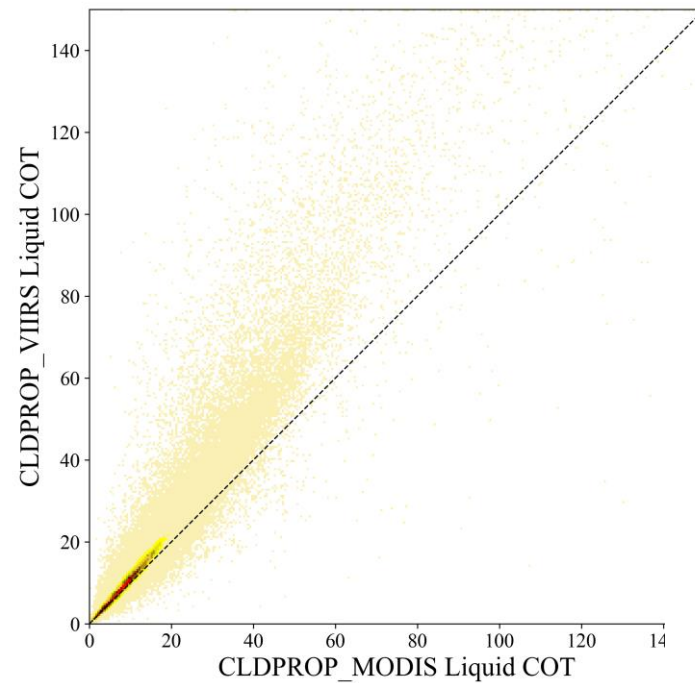
- Initial implementation of continuity cloud optical properties algorithm (CLDPROP) showed large differences between Aqua MODIS and SNPP VIIRS cloud optical thickness (COT) retrievals



Aqua MODIS  
6 July 2014 (0200 UTC)



SNPP VIIRS  
6 July 2014 (0154, 0200 UTC)



- Retrieval differences linked to radiometric differences in analogous Aqua MODIS and SNPP VIIRS spectral channels
  - Above: Liquid COT retrievals from 0.87 $\mu$ m channel (MODIS B2, VIIRS M7)

# Starting Point: Radiometric Match Files

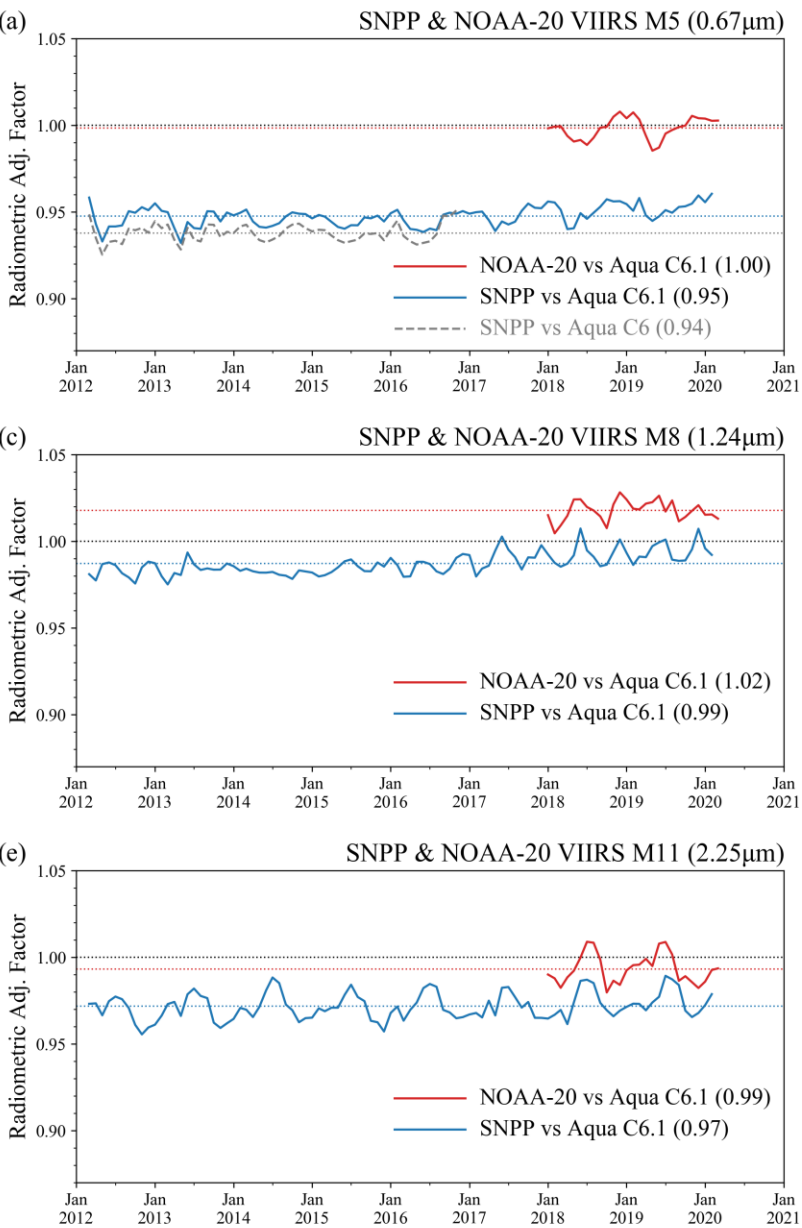
- Developed and processed by Atmosphere SIPS
- Co-located Aqua MODIS and SNPP/NOAA-20 VIIRS data
  - MYD02 L1B vs NASA VIIRS L1B (all M-band spectral channels)
    - Aqua MODIS C6.1; SNPP VIIRS v2.0.2 and NOAA-20 VIIRS v3.0.0 (both “Collection” 1)
  - Key MYD35 and MYD06 geophysical datasets (cloud mask, cloud-top/optical)
- Analysis approach
  - Homogeneous liquid phase clouds over oceans,  $\pm 60^\circ$  latitude
  - Temporal matching:  $\Delta t < 10\text{min}$
  - Strict angle matching: view zenith and scattering angle differences  $< 1^\circ$
  - **Use Aqua MODIS as the benchmark, i.e., scale VIIRS to match MODIS**

# Methodology

- MODIS COT,CER + VIIRS reflectance LUT => **VIIRS expected top-of-cloud reflectance at pixel level**
- MODIS (MYD06) CTP + VIIRS L1B + atmospheric correction => **VIIRS observed top-of-cloud reflectance at pixel level**
- Aggregate pixel-level expected/observed reflectance into monthly joint histograms => monthly VIIRS radiometric adjustment factors
- Final VIIRS (SNPP or NOAA-20) radiometric adjustment factors derived from time series of monthly values

$$\text{VIIRS Radiometric Adjustment}(\lambda) = \frac{\text{VIIRS Expected TOC Repl.}(\lambda)}{\text{VIIRS Observed TOC Repl.}(\lambda)}$$

$$\lambda = [0.67\mu\text{m} (M5), 0.87\mu\text{m} (M7), 1.24\mu\text{m} (M8), 1.61\mu\text{m} (M10), 2.25\mu\text{m} (M11)]$$



- Radiometric adjustments applied to VIIRS L1B prior to ingestion into CLDMSK and CLDPROP algorithms.
  - Both SNPP and NOAA-20
  - Defined as time series (left) means
- Values are reported in CLDPROP L2 global metadata

Open Access Article

### Derivation of Shortwave Radiometric Adjustments for SNPP and NOAA-20 VIIRS for the NASA MODIS-VIIRS Continuity Cloud Products

by Kerry Meyer<sup>1,\*</sup>, Steven Platnick<sup>1</sup>, Robert Holz<sup>2</sup>, Steve Dutcher<sup>2</sup>, Greg Quinn<sup>2</sup> and Fred Nagle<sup>2</sup>

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VIIRS Wavelength (Band Designation)			0.67 μm (M5)	0.87 μm (M7)	1.24 μm (M8)	1.61 μm (M10)	2.25 μm (M11)
Radiometric Adjustment Factor	NOAA-20	vs MODIS C6.1	1.0	1.01	1.02	1.02	0.99
		vs MODIS C6.1	0.95	0.97	0.99	0.98	0.97
	SNPP	vs MODIS C6	0.94	0.96	0.98	0.98	0.97
		Deep Blue Gain Factors	0.941	0.963	1.011	0.981	0.931

# A-SIPS L1B Inter-Instrument Calibration Support

- The co-location and matchfile software are also being leveraged by the aerosol teams (e.g., Sayer et al. 2016) who are focused on dark scenes.
  - Some consistency is seen between the the aerosol team and cloud team approaches, but unresolved differences remain, particularly for the 1.24 $\mu$ m (M8) and 2.25 $\mu$ m (M11) channels (forward models?).
- The cloud team's inter-calibration software is processed in near-real time and continually monitored by the A-SIPS for both SNPP and NOAA-20.
- The co-location and match software are designed to support future instruments including JPSS-2 and advanced GEO (AHI/ABI/AMI)
  - Note: The cloud and aerosol teams are funded to develop GEO products

# VIIRS SNPP/NOAA 20 UW A-SIPS Monitoring Tool

- The cloud team's Aqua MODIS – VIIRS (SNPP and NOAA-20) radiometric analysis code is implemented at A-SIPS and running in NRT
- Web “dashboard” developed by A-SIPS (Z. Griffith) to facilitate monitoring by team
  - “Per cycle” (64 hrs) and rolling (~monthly) means
  - seasonal decomposition for trends



SNPP (Blue)

NOAA-20 (Orange)

MODIS/SNPP VIIRS calibration ratio for the 0.87 $\mu$ m channel begins to increase starting in 2016, to ~0.98 in Dec 2020

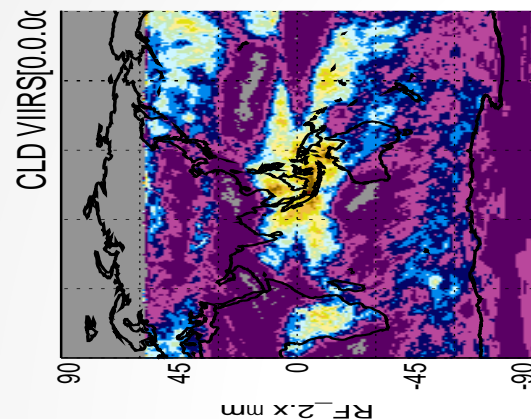
# Is this ~1% drift in 0.87 $\mu$ m relative radiometry important?

2

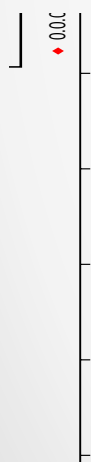
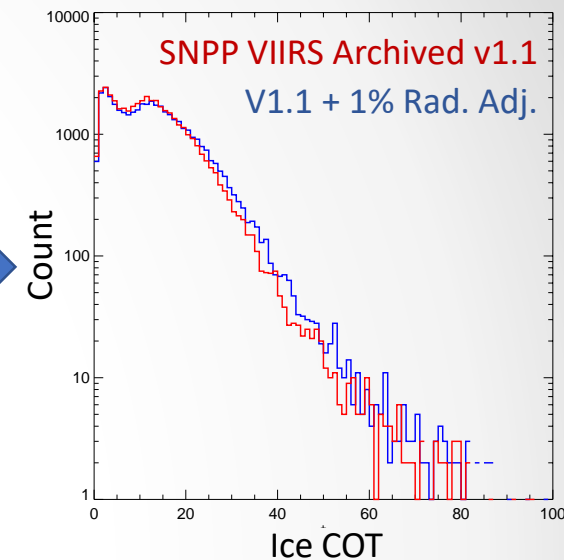
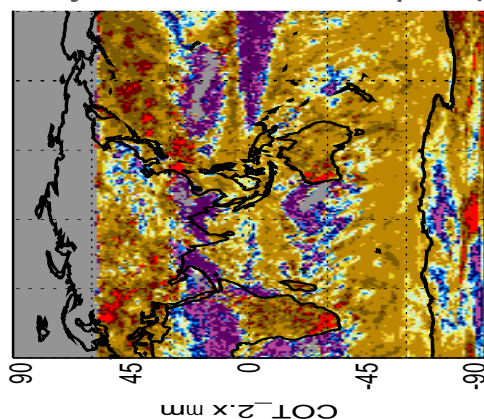
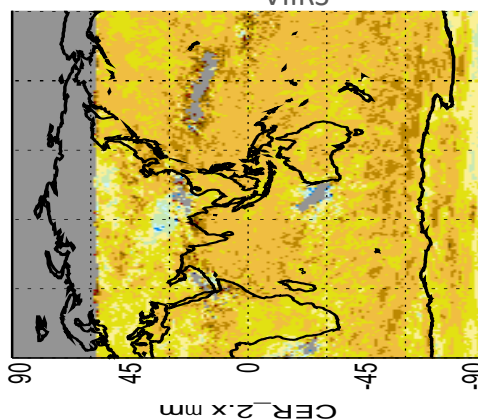
CLDPROP\_M3\_VIIRS\_SNPP.A20203

Retrieval\_Fraction\_21\_Ice

SNPP VIIRS Ice COT, Dec 2020



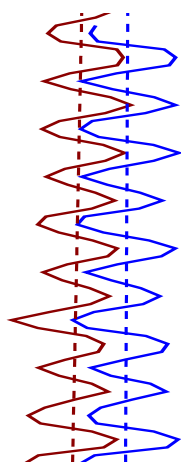
$\Delta\text{COT}_{\text{VIIRS}}$  after 1% adjustment to 0.87 $\mu$ m (M7)



SNPP VIIRS

Aqua MODIS

2 per dec (rel)



8 per dec (rel)



2016 2017 2018 2019 2020

$\Delta\text{COT}_{\text{VIIRS}}$  (Dec 2020)

# Cloud Team Perspective on Inter-Instrument Calibration

- A unified L1B data record, consistent across instruments and tied to a single reference imager with offsets/scaling derived from a consensus approach, is indeed a highly desired goal.
- That said, in practice this may be difficult to achieve given the various, at times divergent, needs of the algorithm and science teams.
  - E.g., bright scenes for clouds vs dark scenes for aerosols
- While MCST/VCST should continue pushing towards the ideal (unless prioritization requires otherwise), the L2 algorithm teams still need to monitor inter-sensor radiometry and apply adjustments as they see fit.
  - Complicating factor: Atmosphere is no longer in the “Collection” paradigm, so team-wide activities, adoption of L1B updates, etc., are less coordinated.